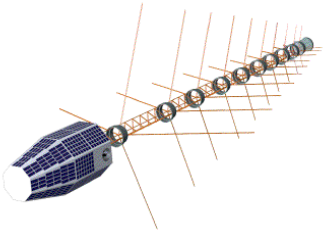
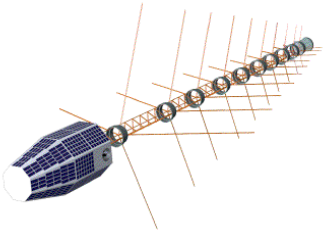


1999 Fall AGU

Near-Stereo VHF Observations of Impulsive Ionospheric Events using the FORTE RF Experiment and the ALEXIS Blackbeard Experiment

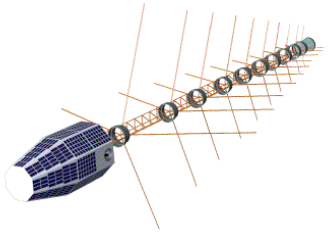
Diane Roussel-Dupré, Dorothea M DeLapp, and Morris B Pongratz

Los Alamos National Laboratory



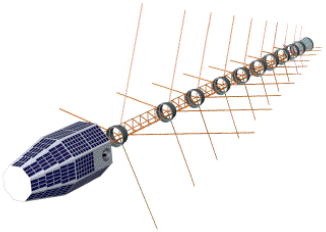
ALEXIS BB/FORTE Joint Collects

- Background
  - » Satellites have similar orbits
    - – ALEXIS: 750 x 850 km, 70 deg inclination
    - – FORTE: 800 x 830 km, 70 deg inclination
  - » Every 2 weeks, ALEXIS & FORTE orbit “beat” such that satellites are in close proximity to each other
  - » Latitude of orbit overlaps are at ≈+/- 20 deg which encompasses regions of equatorial storming



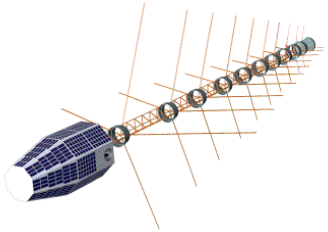
Boundary Conditions for Joint Collects

- Separation distance between satellites < 500 km to maximize footprint overlaps
- Located over regions of more probable activity
  - » Number of attempts/day limited by ALEXIS memory and downlink capability
- Blackbeard antenna used for collects
  - » top-daylight, bottom-dark
- Configuration durations
  - » Blackbeard configured for 2 minutes ≈ duration of time for <500 km separation
  - » FORTE configured for 5-10 minutes centered on overlap time

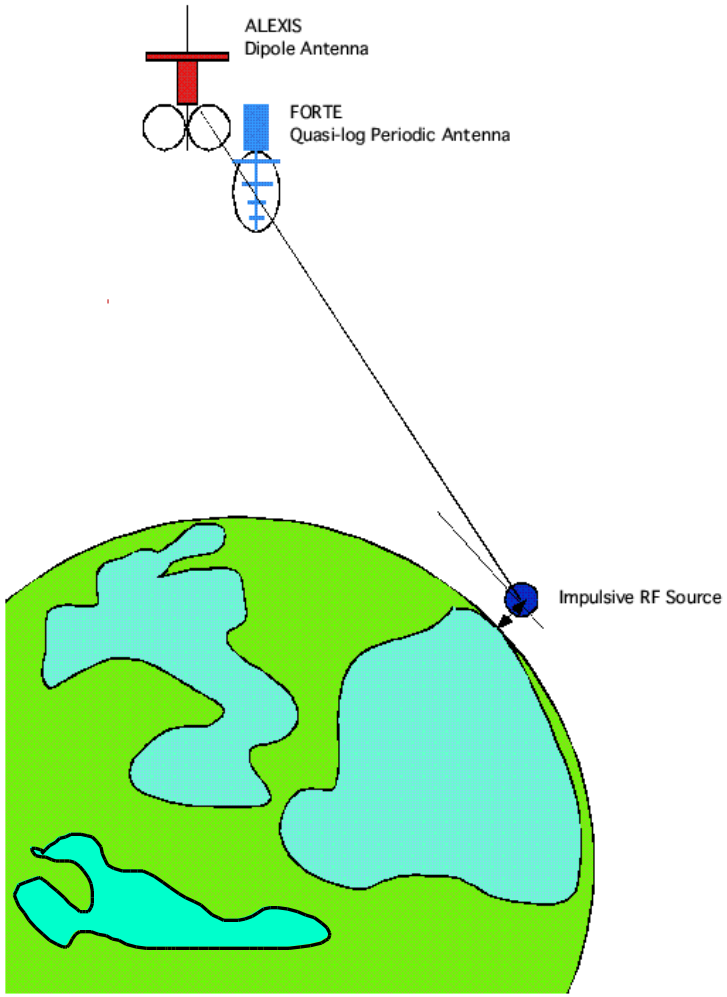


Analysis Method

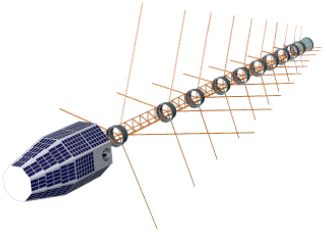
- Exact calibration of the FORTE antenna unknown, thus, used joint Blackbeard-FORTE LAPP events to:
  - » Determine timing accuracy
  - » Determine preliminary antenna lobe pattern
- With preliminary antenna calibration, determine joint event strength and compare strength between two experiments
  - » Joint event observed at similar satellite nadir angle to LAPP events so preliminary calibration should be ≈ okay



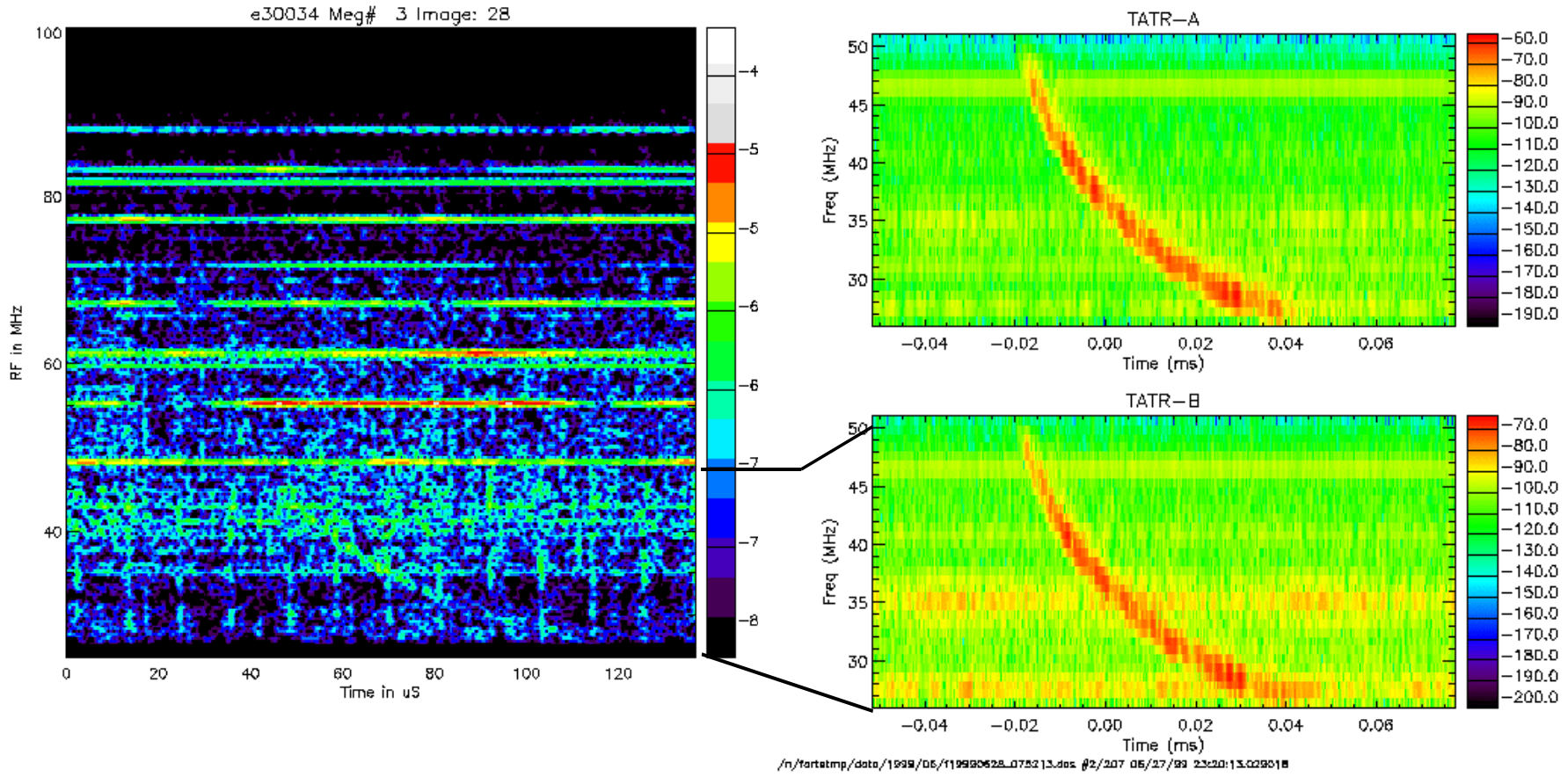
ALEXIS/FORTE Joint Viewing of Impulsive Events



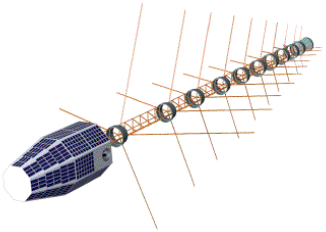
- ALEXIS has simple dipole antenna pattern with nadir null
- FORTE has nadir enhanced antenna pattern
- Most events (lightning & LAPP) have been at large FORTE nadir angles allowing cross calibration at large nadir angles



27 June 1999 Joint ALEXIS/BB-FORTE Event

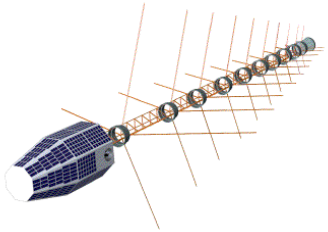


- Photodiode event associated with Blackbeard trigger



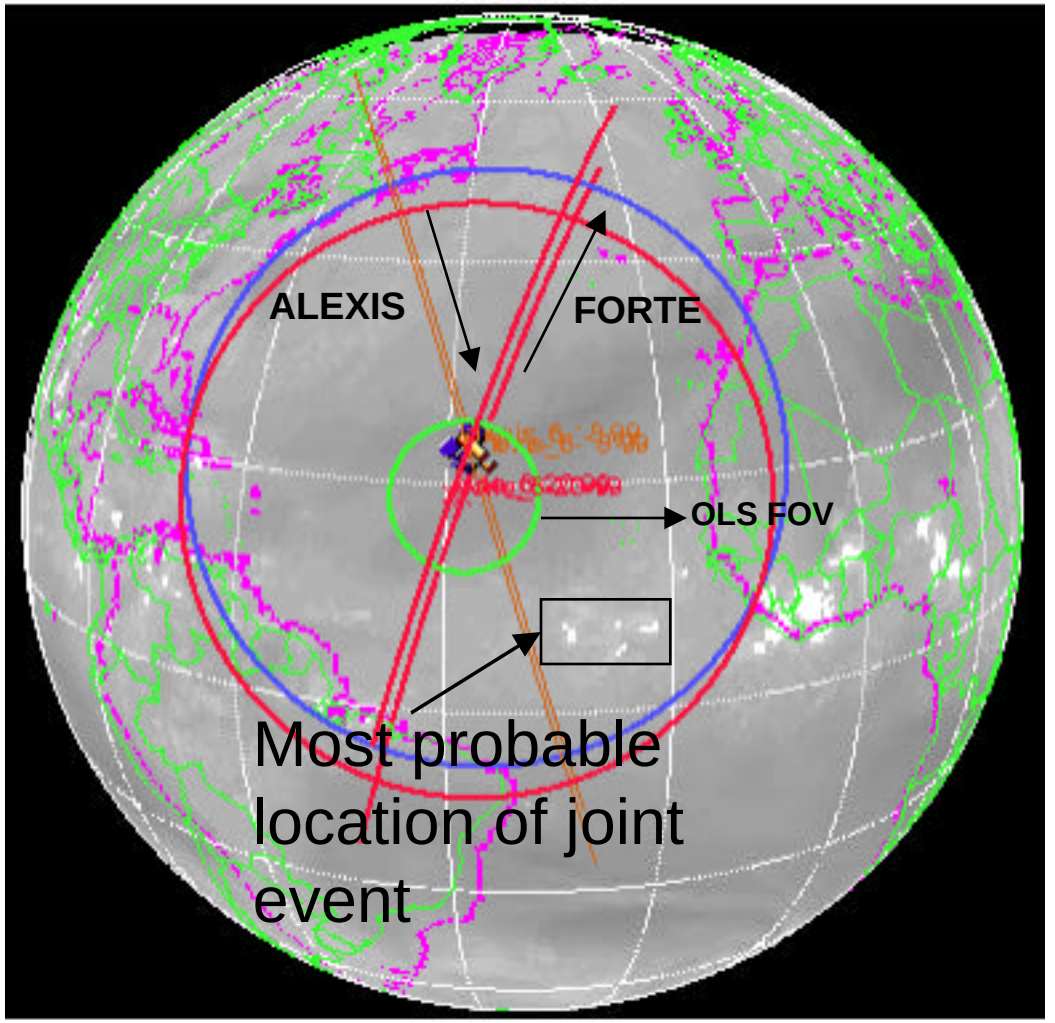
27 June 1999 Joint ALEXIS/BB-FORTE Event

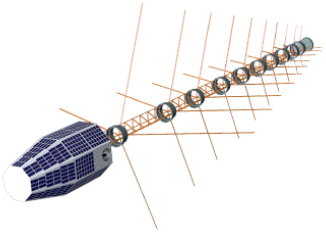
- FORTE
  - » Time: 23:20:13.029
    - » GPS time not available- time good to few ms
  - » TEC: 4.2 (10^{17})
  - » Strength
    - – A: 9.6 E-7 $(V/M)^2$
    - – B: 1.9 E-7 $(V/M)^2$
  - » Antenna Ratio B/A
    - – ≈0.2
    - – Possible angles:
      - 70-110 degree
- ALEXIS-Blackbeard
  - » Time: 23:20:13.0326
  - » TEC: 2.95 (10^{17})
  - » Strength
    - – 2.7 E-6 $(V/M)^2$
- 3 possible storms in this location!



Where Was the Joint Event of 27 June 1999 Located?

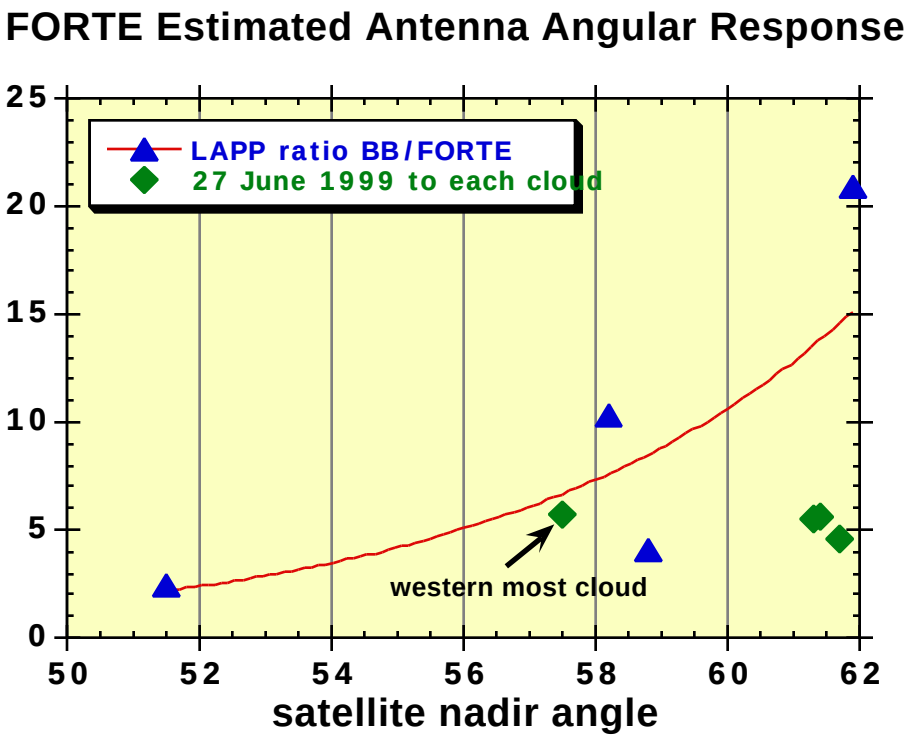
- Time joint event: 23:20:13 27 June, 1999
- Water vapor weather map time 00:00 28 June 1999 and satellite positions
- FORTE angle to “best guess” location for joint event at location of clouds
  - Az: 85, 110 or 125 deg
  - El: ≈60 deg off nadir
- FORTE polarization ratio consistent with cloud location

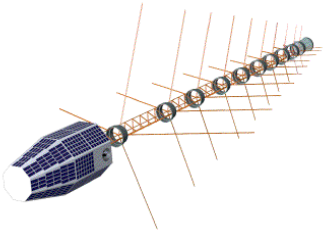




27 June 1999 Particulars

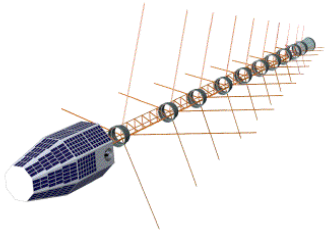
- If assume **isotropic** radiation from impulsive source, get reasonable agreement with LAPP angular response determination for western cloud
- Source strength ≈ 0.4 MW
- Satellite separation as viewed at source 10-20 degree depending on which cloud
- Source elevation angle to satellites ≈ 10 degree



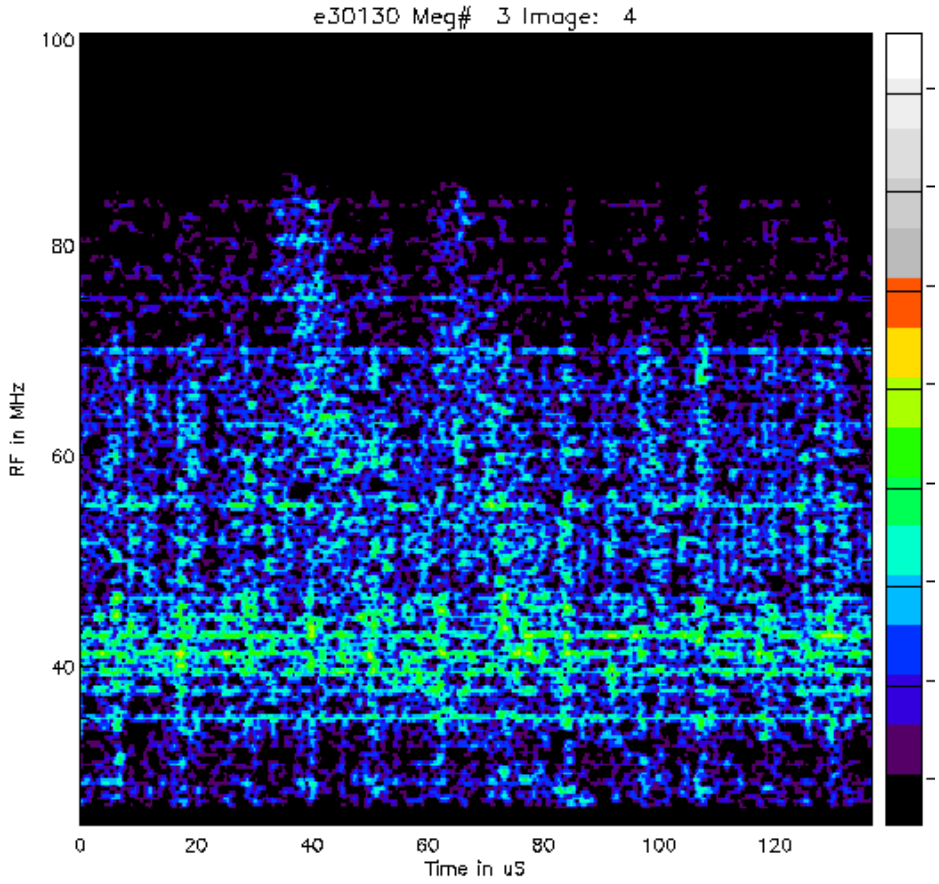


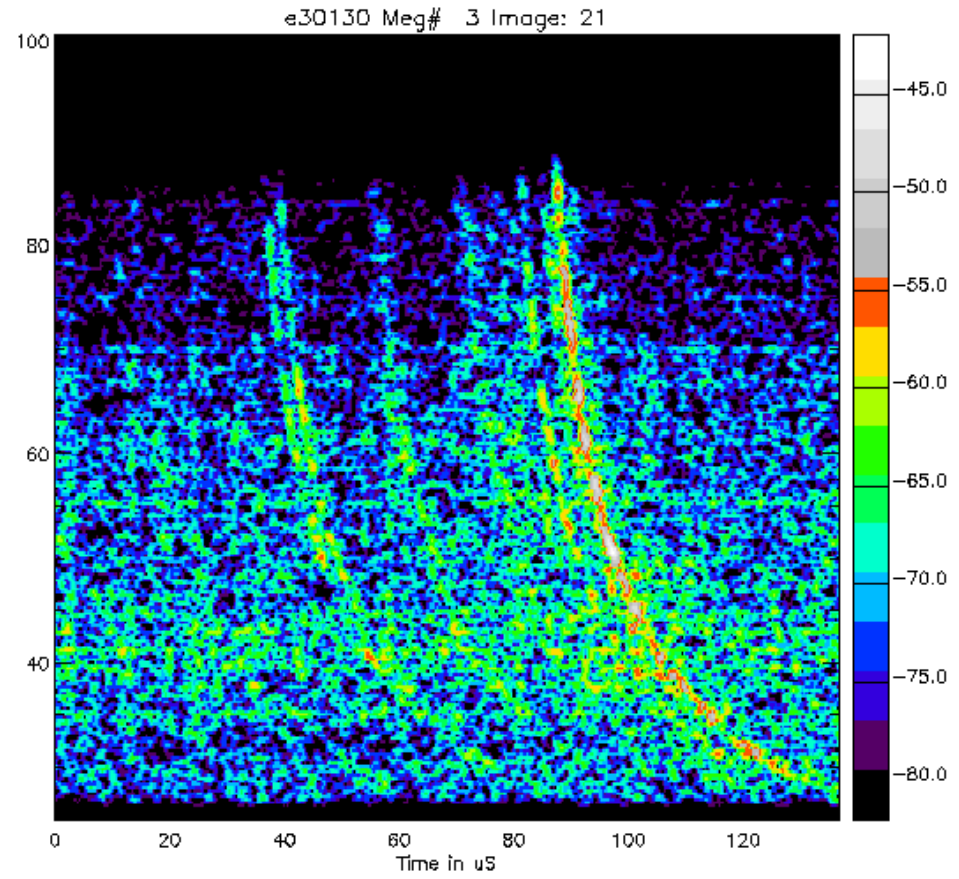
22 November 1999 Blackbeard only Event

- Both Blackbeard and FORTE configured to collect impulsive events
  - » Blackbeard triggered on event at 11:46:01.595 UTC
    - – 2 events in the 5MB record
  - » FORTE's closest triggered event was several seconds away even though collected data throughout trigger window
  - » Was the event over the horizon for FORTE and thus not detected?

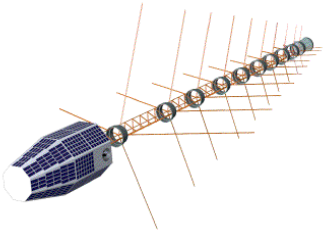


22 November 1999 Blackbeard Events



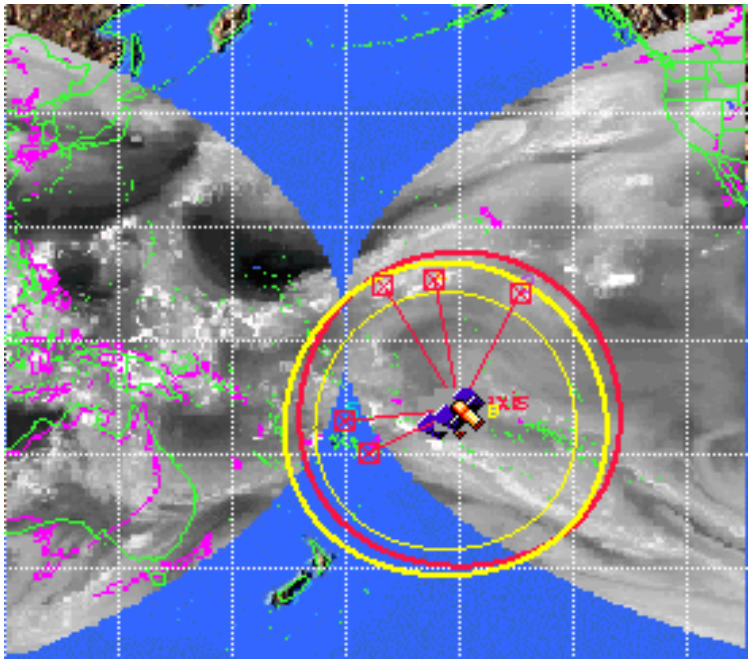


Two Blackbeard events in the 5MB record. Forte did not trigger on either event

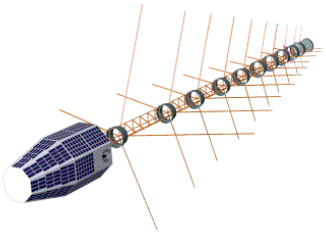


22 November 1999 Particulars

- Blackbeard event
  - » TEC ≈ 2 (10 ^{17})
  - » Signal strength 7E-5 (v/m)^2
  - » non-unique source location
    - – 5 possible clouds
    - – FORTE: 3 clouds over horizon (62.5 degree nadir angle), 2 clouds in FOV
    - – Blackbeard detected range corrected signal strength 14-21 MW which is brighter than LAPP
    - – If in FOV of FORTE, predict isotropic source strength 1.4 MW which should have been detected



Red line is Blackbeard FOV
Yellow line is FORTE FOV
thick: 65 degree
thin: 62 degree
Boxes location of water vapor clouds



Summary

- Used joint Blackbeard-FORTE LAPP calibration pulses to determine preliminary antenna lobe calibration
- Determining correct thresholds for triggering took several attempts
- One joint event observed
  - » Either consistent with isotropic radiation over 10 degrees viewed nearly perpendicular to radial if western cloud or factor of 3 non-isotropic if eastern clouds
- Future work: mining of data in hand to calculate events strengths observed by one satellite and when event not observed by other satellite